# Effect of Quartz Materials on Properties of High Strength (M60) Self Compacting Concrete

**Rajesh.M**
UG student, affiliated to Department of civil engg.,VNRVJIET , Hyd. India.

**Latha sri.U**
UG student, affiliated to Department of civil engg.,VNRVJIET , Hyd. India.

**Blessy Sravya.G**
UG student, affiliated to Department of civil engg.,VNRVJIET, Hyd. India.

**Dr. B.Narendra Kumar**
Professor, Department of Civil engg., VNRVJIET, Hyd, India.

***Abstract: After water, concrete has been becoming the most usable material on this planet earth. Any structure say a residential building, towers, roads, bridges, dams etc, requires a common material called concrete. Though it shows many adverse effects on our environment in the form of carbon emissions, this rapid requirement of concrete has made many inventions and developments on concrete technology so as to have an eco friendly material which exhibits good performance with respect to its properties. One among them is SCC. It is well known that the properties of a concrete material are affected by its cementitious materials and any other admixtures. This investigation was carried out according to the guidelines of European Federation of National Association Representing for Concrete (EFNRAC) in order to determine the fresh and hardened properties of High performance (M60) self compacting concrete when cement content was replaced by quartz powder with a variation of 5% and a decrease in water cement ratio has decreased the porosity of the concrete. Also experimental tests were conducted and the results obtained were accepted in view of EFNARC guidelines. Apart from this, addition of micro silica and other super plasticisers has resulted in the increase of strength and reduction in heat of hydration.***

***Keywords: admixtures, cement ratio, Concrete, high performance, self compacting, water properties, super plasticisers.***

## 1. INTRODUCTION:

Self compacting concrete is a type of concrete that has ability to compact itself by its own weight which doesn't require any vibration. This concrete comes under the category of high performance concrete which has required deformability in the fresh state and high resistance to segregation. To develop SCC proper mix design and selection of materials plays a vital role. It has a wide range of application in the field of construction due to its factorable fresh properties. High performance concrete (HPC) is a type of concrete which exhibits high durability, high strength and high workability. The property and constructability of HPC exceeds the normal concrete. To develop HPC, the raw materials used in normal concrete are varied in order to achieve efficient properties of strength and durability.

## 2. REVIEW OF LITERATURE:

The following papers were studied which gives the summary of work done for the improvement of self compacting concrete.

**2.1. Jianxin Ma and Jorg Dietz:** This paper show the application of super plasticizers and powder content like silica fumes in the high performance of self compacting concrete which resulted in a good workability and quality of the concrete with a water cement range of 0.28 to 0.38. It concludes that addition of 18% of silica (with the weight of cement) was enough to consume the carbon hydroxide released from the cement.

**2.2. Kazumasa Ozawa Et Al:** His investigation focused that the partial replacement of cement with fly ash and blast furnace slag has remarkably improved the flow ability of the concrete. Trying with the different proportions of admixtures the research work concludes that replacement of 10% to 20% of fly ash and 20% to 25% of blast furnace slag by cement content showed the better flowing ability and strength properties.

**2.3. M.Shahul Hameed, V. Saraswathi, A.S.S.Sekar:** His investigation was carried out to determine the effect of rapid chloride permeability on high performance SCC Green concrete. He used Marble Sludge Powder as filler to fill and reduce the voids which subsequently increased the strength of the concrete.

**2.4 Mehta and Neville:**

This investigation shows a way that increment of sand quantity at the cost of coarse aggregate of range 5% so as to reduce the segregation when super plasticizers are added.

## 3. RESEARCH SIGNIFICANCE:

- Micro silica gives stability in fresh concrete. Also it acts as a pumping acid in which it reduces viscosity making the concrete a non segregating concrete.
- It also observed that the micro silica will reduce the risk of blocking when concrete is pumped.
- Replacement of cement with quartz will show environmental benefits as the content of cement is reduced and also improves the serviceability criteria.
- Size of fine particles and reactivity of silica fumes results in lower permeability and improved durability.

## 4. MATERIALS:

### *4.1. Cement:*

Ordinary Portland cement of grade 53 was used and tested for various proportions according to the specifications of IS 4031-1988 and found to confirming as per IS 12269-2013. The specific gravity was 3.5 and fineness was 2800cm$^2$/gm.



*Published By:*
*International Journal of Engineering Research in Current Trends*

#### *4.2. Quartz powder*:

Quartz powder of size 0 to 10 µ mm was used. Its physical properties are specific gravity of 2.63, hardness of 7 @$20^0$F, which is greyish white in colour and odourless. The melting and boiling points are $2912^0$F and $4000^0$F respectively.

#### *4.3. Aggregate*

#### *4.3.1 Coarse aggregate*:

Crushed basalt was used as coarse aggregate. It has a size of varying in the range of 2-5mm. The coarse aggregate has a Specific gravity of 2.67, Bulk density of 1560 kg/$m^3$ and fineness modulus of 6.23.

#### *4.3.2. Quartz sand (fine aggregate):*

The quartz sand used in this investigation has a size range of 0.3-0.8mm.And its physical properties includes specific gravity of 2.65, bulk density of 1650 kg/$m^3$, Fineness modulus of 2.2, with colour of greyish white and odourless. The melting and boiling points are $2912^0$F and $4000^0$F respectively.

#### *4.4 Chemical admixtures:*

Super plasticisers and VMA were used as chemical admixtures.

#### *4.4.1 Super plasticiser:*

Glenium B233 was used as a super plasticiser and its properties are as follows. Glenium B233 has a specific gravity of 1.220 to 1.225 @ $30^0$C, colour of brown, and has no chloride and nitrate content. The freezing point is $0^0$C can be reconstituted if stirred after thawing and also approximately 1% air is entrained.

#### *4.5 Mineral admixtures:*

Micro silica was used as mineral admixture and added as 5% in M60 grade SCC mix to increase the early age strength. It has a composition of silica 92%, alumina 0.46%, iron oxide of 1.60%, lime of 0.36%, magnesia of 0.74%, sulphur trioxide of 0.36%, ignition loss of 2.5

## 5. MIX PROPORTIONS:

***Table1. Mix design proportions:***

| Mix Designation | Cement (kg/$m^3$) | Crushed basalt Kg/$m^3$ | Micro Silica (kg/$m^3$) | Quartz % Replaced by wt of cement | Quartz powder (kg/$m^3$) | quartz Sand (kg/$m^3$) | Quartz sand (kg/$m^3$) | Coarse aggregate (kg/$m^3$) | SP % of powder content | VMA % of powder content | Water Kg/$m^3$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| HSSCC 1 | 570 | 612 | 30 | 0 | 0 | 918 | 0 | 800 | 2 | 1 | 180 |
| HSSCC 2 | 570 | 612 | 30 | 10 | 60 | 918 | 182 | 800 | 2 | 1 | 180 |
| HSSCC 3 | 570 | 612 | 30 | 15 | 90 | 918 | 364 | 800 | 2 | 1 | 180 |
| HSSCC 4 | 570 | 612 | 30 | 20 | 120 | 918 | 545 | 800 | 2 | 1 | 180 |
| HSSCC5 | 570 | 612 | 30 | 25 | 150 | 918 | 728 | 800 | 2 | 1 | 180 |
| HSSCC 6 | 570 | 612 | 30 | 30 | 180 | 918 | 910 | 800 | 2 | 1 | 180 |
| HSSCC 7 | 570 | 612 | 30 | 35 | 210 | 918 | 910 | 800 | 2 | 1 | 180 |

The following table shows the mix proportions all the materials.

## 6. FLOW PROPERTIES:

According to the specifications of EFNARC, the material was tested for the flow properties. The tests include slump funnel, v-funnel, L box. The results obtained are tabulated as shown.

***Table 2 Flow properties of the material.***

| Mix Designation | Slump tests | | V funnel | | L Box | | | U box |
|---|---|---|---|---|---|---|---|---|
| | Slump mm | T 50 (sec) | T(sec) | T5(sec) | T20 (sec) | T40 (Sec) | H2/H1 | H2-H1 (mm) |
| HSSCC 1 | 715 | 4.0 | 7 | 8 | 7.0 | 6.28 | 0.89 | 10 |
| HSSCC 2 | 695 | 3.0 | 6 | 7 | 8.0 | 6.7 | 0.83 | 14 |
| HSSCC 3 | 720 | 3.5 | 6 | 8 | 8.0 | 6.9 | 0.87 | 6 |
| HSSCC 4 | 770 | 4.0 | 4 | 5 | 6.6 | 5.5 | 0.84 | 2 |
| HSSCC5 | 720 | 3.5 | 5 | 6 | 6.0 | 5.28 | 0.93 | 4 |
| HSSCC 6 | 760 | 4.0 | 6 | 7 | 6.0 | 5.5 | 0.91 | 8 |
| HSSCC 7 | 750 | 4.0 | 5 | 6 | 7.0 | 6.5 | 0.92 | 10 |

***Fig i) Slump flow properties:***

The following graph shows the variation of slump flow for all the mix designs:

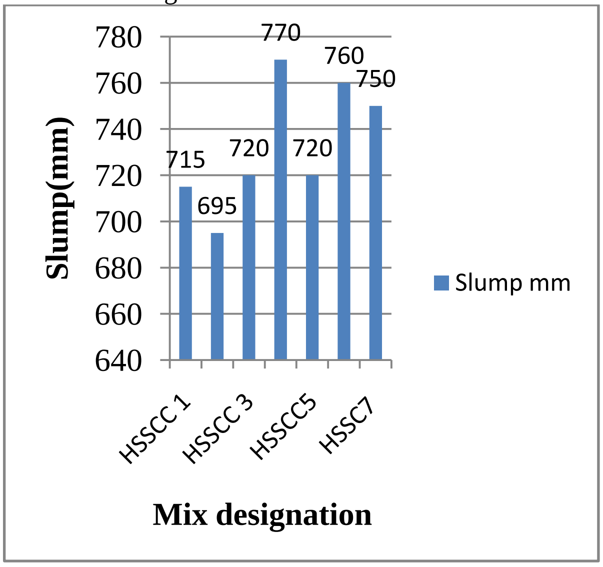



***Fig ii) L box H2/H1 ratio properties:***

The graph shows the variation of the ratio H2/H1.

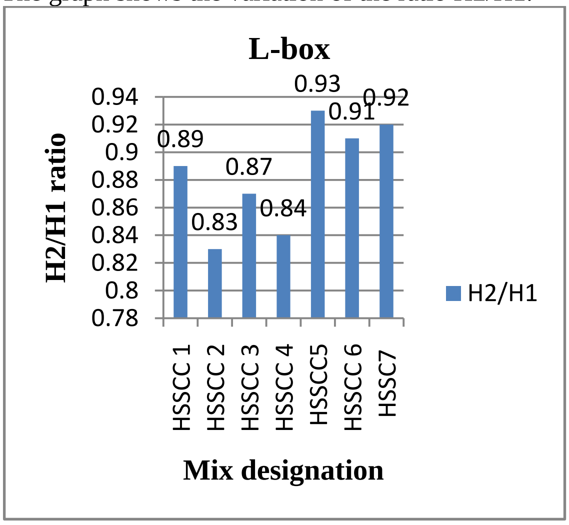
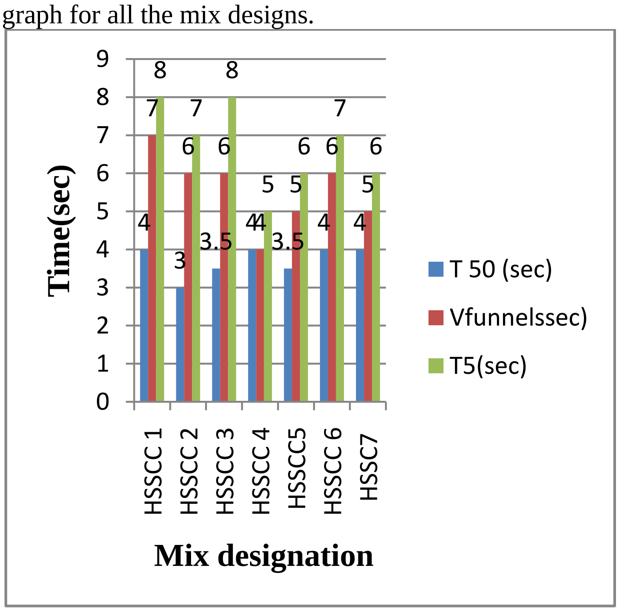



***Fig iii) Variations of T50, V-funnel, T5 for HPSCC:***

The variation of T50, V funnel,T5 are shown below in the graph for all the mix designs.




**7. MECHANICAL OR HARDENED PROPERTIES:**

***7.1 Compressive strength:***

***Table 3: Properties of compressive strength:***

| Mix designation | Compressive strength(MPa) | | |
|---|---|---|---|
| | **7 days** | **28 days** | **90 days** |
| HSSCC 1 | 54 | 71 | 73 |
| HSSCC 2 | 50 | 68 | 71 |
| HSSCC 3 | 51 | 69 | 72 |
| HSSCC 4 | 50 | 70 | 73 |
| HSSCC5 | 53 | 72 | 75 |
| HSSCC 6 | 51 | 71 | 74 |
| HSSCC 7 | 50 | 70 | 72 |

The following table shows the compressive strength of the materials when tested 7, 28, 90 days respectively.

*Fig iv) Compressive strength:*

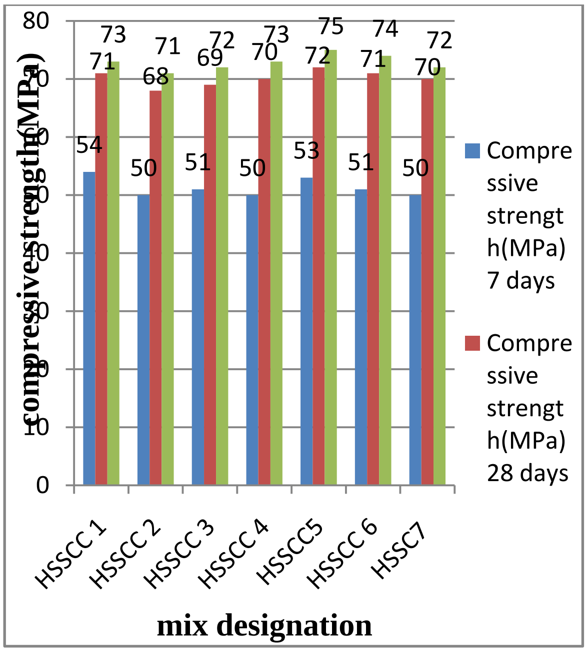
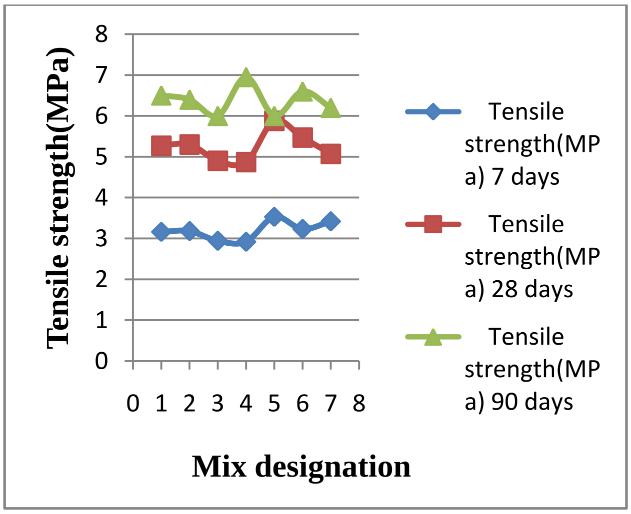



***Fig v) Tensile strength***



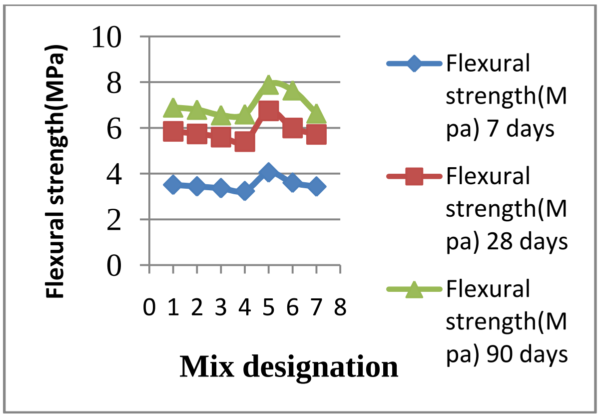

***7.2 Split tensile strength:***

The materials are tested for split tensile strength for 28 days and the observed values are tabulated as shown.

*Table 4.Properties of split tensile strength*

| Mix no | Tensile strength(MPa) | | |
|---|---|---|---|
| | 7 days | 28 days | 90 days |
| HSSCC 1 | 3.162 | 5.27 | 6.50 |
| HSSCC 2 | 3.18 | 5.30 | 6.40 |
| HSSCC 3 | 2.94 | 4.9 | 6.0 |
| HSSCC 4 | 2.92 | 4.87 | 6.95 |
| HSSCC5 | 3.53 | 5.88 | 6.0 |
| HSSCC 6 | 3.23 | 5.47 | 6.6 |
| HSSCC 7 | 3.42 | 5.07 | 6.2 |

*Fig vi) Flexural strength*




### *7.3 Flexural strength:*

The materials are tested for flexural strength and the observed values are tabulated below.

*Table5. Properties of flexural strength:*

| Mix no | Flexural strength(Mpa) | | |
|---|---|---|---|
| | 7 days | 28 days | 90 days |
| HSSCC 1 | 3.51 | 5.85 | 6.9 |
| HSSCC 2 | 3.44 | 5.74 | 6.8 |
| HSSCC 3 | 3.36 | 5.60 | 6.56 |
| HSSCC 4 | 3.24 | 5.40 | 6.60 |
| HSSCC5 | 4.05 | 6.75 | 7.90 |
| HSSCC 6 | 3.6 | 6.00 | 7.65 |
| HSSCC 6 | 3.43 | 5.72 | 6.64 |

## 8. CONCLUSIONS:

- At the optimum content of quartz powder ( @ 25% replacement of M60 grade cement), the strength of HPSCC of M60 grade is found to be slightly higher than the strength of corresponding grade SCC mixes without quartz powder.
- Also the workability of the material has increased beyond 15% of quartz powder content.
- It was observed that the setting time has prolonged with the replacement of cement with quartz partially.
- Permeability of concrete was also observed to be increased with the addition of quartz powder and micro silica.
- Increase in compressive, split tensile and flexural strengths is obtained by combining micro silica and quartz powder in HPSCC.
- This investigation shows the increase in compressive strength as 2%, 1.4% and 2.8% for 7, 28, and 90 days respectively when compared to SCC without any addition of quartz powder @ 25% replacement of cement with quartz powder.
- This investigation shows the increase in split tensile strength as 11.6%, 11.57% and 7.8% for 7, 28 and 90 days respectively when compared to SCC without any addition of quartz powder @ optimum content of quartz powder.
- This investigation shows the increase in flexural strength as 15.4%, 15% and 14.4% for 7, 28, and 90 days respectively when compared to SCC without any addition of quartz powder @ optimum content of quartz powder.
- The strength is not affected even though HPSCC is developed at cheaper costs with the optimum percentage replacement of mineral admixtures**.**

## REFERENCES:

[1] A. Ravichandran, K. Suguna and P.N. Ragunath, Strength Modelling of High-Strength Concrete with Hybrid Fibre (combination of steel and polyolefin fibres)Reinforcement. American Journal of Applied Sciences: 219-223, 2009 ISSN 1546-9239.

[2]Abhishek.S Shetji and C. Vipulanandan, “Flow properties of self compacting concrete with time”, CIGMAT-2004 conference and exhibition.

[3] A.M.Boddy, R.D.Hooton,M.D.A.Thomas.” The effect of the Silica content of Silica Fumes onits ability to control alkali-silica reaction”. Cement and Concrete Research 33 (2003)Pg1263-1268.

[4] A.Elahi, P.A.M.Basheer, S.V. Nanukuttan, Q.U.Z.Khan.” Mechanical and Durability properties of high performance concrete containing Supplementary cementitious materials”. Construction of Building materials 24(2010)Pg 292-299.

[5] B.Mobasher and T.M. Mitchell, Laboratory Experience with the Rapid Chloride Permeability Test,” Permeability of Concrete, SP-108, 1988, ACI.Moreno,J., “High-Performance Concrete: Economic Considerations,” Concrete.

[6] D. Whiting and L. Kuhlmann, “Curing and Chloride Permeability,” ConcreteInternational, Aprial 1987, ACI.

[7] D. Whiting, G.W. Seegebrecht, and S. Tayabji, “Effect of Degree of Consolidation onSome Important Propertiesof concrete,” Consolidation of Concrete, SP-96, 1987.

[8]EFNARC, “Specifications and guidelines for self compacting concrete”, www.efnarc.org

[9] Hajime Okamura and Masahiro Ouchi “Self Compacting Concrete” by; Journal of advanced Concrete Technology, Vol 1, No.1, 5-15, April 2003

This Paper is presented in conference
Conference Title : Advances in Mechanical, Industrial and Material Engineering (AMIM-2020)
Organised By : Mechanical Department, Sagar Institute of Research and Technology-Excellence, Bhopal, MP
Date : 28-May-2020